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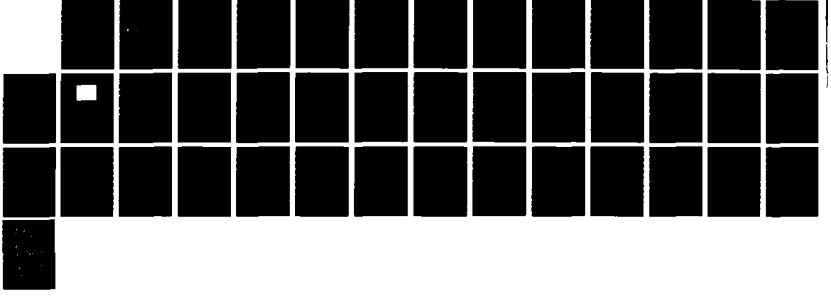

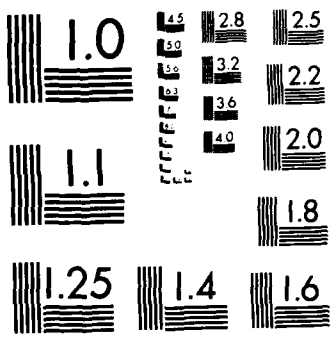

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A Technique for Recording HF Oblique-Incidence-Sounder Data

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Ionospheric Effects Branch
Space Science Division

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This report documents the equipment, software, and procedures developed for digitization, recording, and display of high-frequency propagation data produced by the AN/TRQ-35 RCS-4B oblique-incidence sounder receiver. The data format is described in detail so that it could be used as a basis for an oblique-incidence sounder data base accessible by any organization interested in HF propagation problems.

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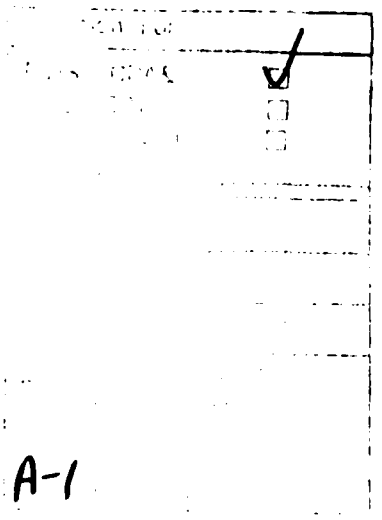

A TECHNIQUE FOR RECORDING HF OBLIQUE-INCIDENCE-SOUNDER DATA

I. Introduction

This report details the equipment, formats, and procedures developed for recording and displaying HF propagation data produced by the AN/TRQ-35 RCS-4B oblique-incidence sounder receiver. The information is being published in this form because of numerous requests regarding a means for using the large volume of sounder data accumulated by NRL in the course of its ionospheric effects studies. These techniques may ultimately be incorporated in a proposed world-wide data base of ionospheric data.

The AN/TRQ-35 sounder equipment is available to all branches of the DoD and is widely used for near-real-time HF frequency management. The data it produces, if properly recorded and stored, can also be used for numerous other purposes related to studies of ionospheric structure and HF skywave communications. These include studies of the electron density versus height profile of the ionosphere; of forecasts of propagation conditions relevant to HF communications; of the geographical and temporal limitations of sounder data application; and of the effectiveness of frequency management techniques. Permanent records of ionospheric propagation have also proved valuable in evaluating tests of HF devices which are dependent on ionospheric propagation, such as communications transmitters and receivers, or direction finding equipment.

The recording equipment described here was developed to record the data efficiently and to make its retrieval easy. Once set up, the recording equipment requires a minimum of operator attention, since the data need be transferred to tape only once per day. The sounder data, in the form of ionograms, are stored in a compact form: four day's worth of data from one sounder receiver can be stored on a 1/4" magnetic tape cartridge of dimensions 153mm x 102mm x 17mm. The system records the amplitudes of the HF signals received, so the ionogram can be later reconstructed with various discrimination levels. With such post-processing it is sometimes possible to detect propagating modes not otherwise apparent.

II. Data Taken from the Sounder Receiver

Figure 1 shows a photograph of both the original CRT display from a sounder receiver and the ionogram data after being digitized, recorded, and

Manuscript approved May 16, 1988

displayed with the equipment described in this report. The main part of the display shows the relative propagation delay times (over a 0-5 msec range) of HF signals as a function of frequency (over a 2-30 MHz range). Above the main display is a display of the receiver's AGC voltage, which is a measure of the amplitude of the strongest (in the range -120 to -65 dBm) mode.

The sounder signals relevant to data recording are listed in Table 1. Although the signals are developed inside the receiver in digital form, most of them are externally accessible only as analog voltages. The propagation delay time data are presented as a sequence of 279 60-msec voltage sweeps, each corresponding to a specific frequency, which arrive at 1-second intervals. In each of these 0-60 msec time intervals the analog voltage represents the variation in the RF signal strength over relative propagation delay times of 0-5 msec. The beginning of ionogram data output is signalled by a TTL trigger pulse (labelled "SA Sync") which goes low at the beginning of the ionogram and stays low until the 279th sweep has been delivered. The onset of each sweep is announced by another TTL trigger pulse (designated "SRS"). The Jth sweep characterizes propagation at the frequency

$$f\ [\text{Mhz}] = 1.95 + 0.1\ J\ .$$

The voltage (0-5 volts) of each sweep is sampled at 200 points within the 60-msec interval, so that the Ith sample corresponds to the time delay

$$t\ [\text{msec}] = 0.025\ I.$$

The 300-microsecond sampling interval was chosen to be somewhat less than the time constant of the output electronics.

The time-delay information is thus contained in 279 x 200 = 55800 voltage samples, each of which represents the HF signal amplitude for a unique combination of frequency and propagation time delay. On the CRT, each of the 279 sweeps corresponds to a vertical line at the appropriate frequency, parts of which are illuminated whenever the signal amplitude exceeds a threshold value. When the digitized data are used to recreate an ionogram, a 279 x 200 pixel array is created and each pixel I,J for which the corresponding amplitude exceeds the threshold amount is illuminated. Most of the storage space is used to store these amplitude values.

The AGC signal is also presented externally as an analog voltage. This voltage is sampled 279 times during each ionogram, one measurement immediately following each 60-millisecond sweep.

In addition, three TTL logic outputs from the receiver indicate which one of the three paths for which the sounder can be set up is being sounded.

III. Recording Instrumentation

The electronic equipment used in the data recording system is listed in Table II and illustrated in the block diagram of Figure 2. The last item, a 3-

1/2" Flexible Disc Drive, is included in Table I because some means is required initially to load the Operating System and the ADC Interface Software into the computer. In typical use this software is usually also stored on both the fixed disc and on the cartridge tape, so that the flexible disc drive is not required.

The electrical connections between the components are illustrated in Figure 3. The circuitry required to electrically isolate the SA Sync pulses, which come once per second during the 279-second ionogram recording period, is diagrammed in Figure 4. This circuitry also generates an addition TTL signal (called EPCON), which starts with each SA sync pulse but lasts for about 450 msec, to maintain the A/D converter in an enabled state until all of the required signals have been digitized.

IV. Computer Programming Details

Data collection is controlled by the BASIC computer program CHIRP4, a listing for which is given in Appendix A. In normal use, the data collection system computer is configured with a memory of 1.6 Mbytes, of which approximately 1.0 Mbytes are used to store the HP BASIC 4.0 System with all of its Drivers and Language Extensions. (Some space could be saved by omitting some of the unneeded Drivers and Language Extensions.) The CHIRP4 program requires about 300 Kbytes. A considerable amount of effort has been expended to make the program user-friendly. Prompts have been built in to explain information to be entered by the user.

Each ionogram recorded by the system is given a name corresponding to the nominal time (Zulu) at which that ionogram started. For example, the ionogram 02FE881215 was collected starting 1215Z on 2 February 1988. Nominal times are all integral multiples of 5 minutes, corrsponding to the twelve sounder time slots each hour.

While running, the CHIRP4 program requires the following fixed disc files:

File Name	File Type	Size
IONOGRAMS	BDAT	16,645,600
PATHDATA	BDAT	5,000
GRAMGRID	BDAT	51,200

Any of these files may, but need not, exist when the program is started. If the program requires one of these files and it doesn't exist, it will create the file.

The IONOGRAMS file stores the data for up to 291 ionograms, in the format described in Tables III, IV, and V. The data in each ionogram is stored in 143 records, each of 400 bytes length. Since each amplitude sample from the ionogram data requires only a single byte of memory, two samples have been compacted into each 2-byte computer (integer) word.

The PATHDATA file is a small file which stores the names, start time delays, and operating segments for the three paths currently being sounded. When sounder paths on the RCS-4B receiver are changed, this file should be updated with the CHANGE PATHS function, which will prompt the operator to enter the new path information. If the PATHDATA file does not exist when the program is started, the file will be created and default-loaded with data for three paths commonly used at NRL.

The GRAMGRID file contains graphics data with which the ionogram grid and labels can be displayed on the CRT with a simple GLOAD command, rather than being produced in a long series of PLOT and LABEL sequences. While the saving in time is only about two seconds, this amount of time can be critical if the paths chosen require that one ionogram be started very soon after the previous one is concluded. When the RECORDing or DISPLAYing function is started, the program attempts to find the graphics data in RAM memory; if not found there, it goes to the fixed-disc memory; and failing that, the grid and labels are generated with the subprogram Plot_grid. If the grid data must be generated, a GRAMGRID file is created and the grid data stored there.

For some purposes it is useful to compile the program with the BASIC 4.0 Compiler produced by IEM, Inc., P. O Box 8915, Fort Collins, CO 80525. The compiled version is of no advantage when recording data, but can reduce the time required to DISPLAY and produce hard copies of a series of ionograms by about 30%.

V. OPERATING PROCEDURES

With the equipment indicated in Figure 2, data collection is controlled by RUNning the program CHIRP4. A listing of this program appears in Appendix 1. Most operations are initiated by "softkeys", the labels for which appear on the CRT and form the MENU for the user. Data collection and storage are accomplished by the following functions:

RECORD function: Data collection is started by pressing the softkey corresponding to RECORD on the MENU. The user is first presented with the current time on the computer clock and the three path descriptions with which the program will label the ionograms from the three sounder paths. Since accurate time and path information are essential to the integrity of the data, the user is requested to verify the correctness of this information. The program waits for the start of the next ionogram and then records it and all following ionograms until RECORDing is stopped with the QUIT softkey. Up to 281 ionograms, equal to the full sounder output for slightly over 24 hours, can be stored in the IONOGRAMS file, after which the data must be transferred to magnetic tape for permanent storage. The operator may also stop the program with a PAUSE or RESET computer command. When data RECORDing is again started, the computer remembers the previously recorded ionograms. Thus, if the computer records 20 ionograms and then is stopped, it will start recording ionogram number 21 when RECORDING is again started. If the computer is stoped in the middle of an ionogram, the fractional ionogram is not retained in storage.

DISPLAY Function: This softkey function displays any ionogram whose data exist on the hard disc. The operator is prompted for the name of a single ionogram, or for a list of ionograms to be displayed. When a series of ionograms is selected, the operator may choose which paths shall be chosen. Hard copies are automatically produced, two per page. The computer requires about 110 seconds to display an entire ionogram.

Transfer of Data to 1/4" Cartridge Tape function: The fixed-disc file IONOGRAMS holds 291 ionograms, just over 24 hours worth. Approximately once per day the data must be transferred to tape for permanent storage and the hard disc purged so that more data can be stored. The data can be transferred to tape when less than 291 ionograms have been recorded, but the amount of cartridge tape used is not reduced because the IONOGRAMS file has to be created with a fixed length. A cartridge can contain four transferred files, which are typically named IONOGRAMS1, IONOGRAMS2, IONOGRAMS3, and IONOGRAMS4. This procedure is done manually, rather than with a softkey:

1. Stop the computer with the QUIT softkey function;

2. Insert tape cartridge into the HP7942 drive. The unit will perform housekeeping tasks for about two minutes before being ready for data transfer;

3. Transfer data with the command:

COPY "IONOGRAMS" TO "IONOGRAMS1:7942,1402,1" [RETURN]

(Instead of IONOGRAMS1, use IONOGRAMS2, IONOGRAMS3, or IONOGRAMS4 respectively to transfer the 2nd, 3rd, and 4th loads of ionograms to the tape.) Transfer takes about 15 minutes. If you want to verify that the data have been transferred, or are uncertrain about how many files have been transferred to the tape, you can get a catalog of files recorded on the tape with the command

CAT ":7942,1402,1" [RETURN]

4. If a list the the transferred ionograms is desired, press the LIST GRAMS key.

5. PURGE data from the fixed disc.

LIST GRAMS Function: This soft key function produces a CRT listing of all ionograms stored on the fixed disc, and the operator is offered the opportunity to have a hard copy. If the computer has not been PAUSED since the last RECORDing session, the list is available immediately. Otherwise, it can take up to about 20 seconds for the information to be read from the fixed disc.

PURGE Function: This softkey function resets the count of recorded ionograms to zero. (Ionogram data are not actually erased, because that is a time-consuming operation. New ionograms are written over the old ones, and the count is advanced after each new ionogram is completed.) To avoid accidental purges, the operator is asked twice to respond affirmatively to a question regarding his desire to purge the data file.

CHANGE PATHS Function: The data collection program automatically labels data for each ionogram with path name, delay time, and operating segments. If a sounder channel is changed to monitor a different transmitter, the identifying data in the computer must also be changed. The CHANGE PATHS function prompts the operator to enter the new data. The changed identifying information is automatically stored in the fixed disc file PATHDATA so that it will be available even if the computer is switched off and then restarted.

SET TIME function: This softkey function is included to make it easy to set the computer's internal data and time clock. The time should be set with an accuracy of $\pm$ 1 second, for which WWV is usually an appropriate standard. Operator is prompted first for date and then for time ZULU; in either case, RETURN leaves the current entry unchanged. When a changed time or date is entered, the clock is set as of the instant of pressing RETURN.

Table I. Electronic Signals Extracted at Jack J7
from the Barry RCS-4B Sounder Receiver

PIN	BARRY SIGNAL DESIGNATION	SIGNAL DESCRIPTION
1	GND	Ground
2	S/A Sync	Spectrum Analyzer (S/A) Sync; TTL LO during each 60-msec data transfer period (sweep)
3	S/A Spectrum Out	Time-of-arrival data: 0-5 v (=> signal strength) for a 0-60 msec period (=> 0-5 msec relative time delay), once for each of 279 sweeps
4	S/A Clock (3.3 kHz)	(not used in data collection system)
5	Sweep Run/Stop (SRS)	TTL LO during each 279-sec ionogram data collection period
6	Receiver AGC Voltage	Signal strength data: 0-5 v (=> -110 to -55 dBm), strength of strongest mode
7	Upper Frequency Limit (UFL)	Sounder scanning range: LO => 2-30 MHz; HI => 2-16 MHz
8	Path 1	TTL LO when path 1 is being sounded
9	Path 2	TTL LO when path 2 is being sounded
10	Path 3	TTL LO when path 3 is being sounded
11	nc	
12	nc	

Table II
Electronic Components comprising the Data Collection System

1. Barry Research Corporation RCS-4B Chirpsounder Receiver

2. NRL-made pulse-shaping circuitry (See circuit diagram,Figure 4.)

3. Hewlett Packard Company (HP) 300-Series computer, Model 98580A Bundled System, option 4 (Operating System on 3 1/2" Flexible Discs); includes HP35731A Graphics Display CRT (medium resolution, bit-mapped, monochromatic Display)

   3a. HP 98620B DMA controller

   3b. HP 98625 HPIB Hi-speed disc interface

   3c. HP 98640A 7-channel ADC interface

   3d. HP 98645A software for ADC interface, Option 630 (3 1/2" flexible disc)

4. HP 7942 24 Mbyte Winchester/65Mbyte cartridge tape drive

5. Black Box Company 488 data buffer

6. HP Thinkjet printer

7. HP 9122S 3 1/2" flexible disc drive

TABLE III. Organization of the IONOGRAMS file, which is created as a data (BDAT) file of 41614 records, each of length 400 bytes.

Records	Contents
1 - 143	Data for Ionogram 1
144-286	Data for Ionogram 2
287-429	Data for Ionogram 3
.	.
.	.
.	.
41470-41613	Data for Ionogram 291
41614	Number of ionograms recorded in the file, in I4 format

TABLE IV. Contents of the 143 records, of length 400 bytes each, comprising the data for a single ionogram.

Record	Contents
1	Header (396 characters)
2-3	AGC data (279 two-byte integers, representing the AGC values for the 279 sounder sweeps)
4	Ionogram data for sweep 1 (200 two-byte integers representing the amplitudes for the 200 digitized ionogram pixels of sweep 1)
5-143	Ionogram data for sweeps 2-279 (200 two-byte integers, representing the amplitudes for the 200 digitized pixels of each of two adjacent sweeps. The less-significant bytes contain amplitude data for one sweep, and the more-significant bytes contain amplitude data for the following sweep.)

TABLE V. Description of the 440-byte Header record.

Character	Contents
1-10	Ionogram name (for example: 03JA871345, which describes the nominal Zulu date and time of ionogram start)
11-12	" " (2 blank characters)
13-40	Path name (for example "TINKER TO FT HUACHUCA "
41-48	Sounder path number (1,2,or 3; for example: " PATH 2")
49-50	" "
51-56	Time delay of sounder transmitter start (for example: 01M50S)
57-58	" "
59-69	Date of start of sounder transmission (for example: 15 Jan 1988)
70-71	" "
72-79	Zulu time of start of sounder transmission (for example: 16:17:11)
80	"Z" (referring to Zulu time)
81-400	Blank

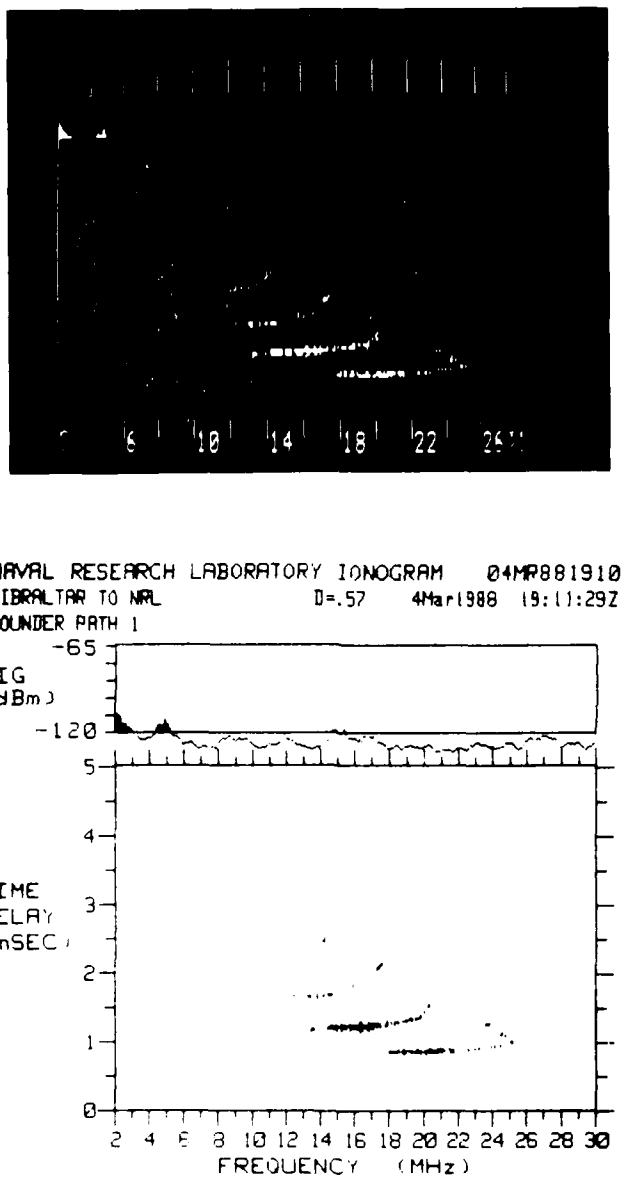

Figure 1. Ionogram 04MR881910, representing HF propagation over the Gibraltar (UK) to NRL path. Top: a photograph of the CRT display on the RCS-4B sounder receiver. Bottom: the same data after digitization and display on the NRL data recording system.

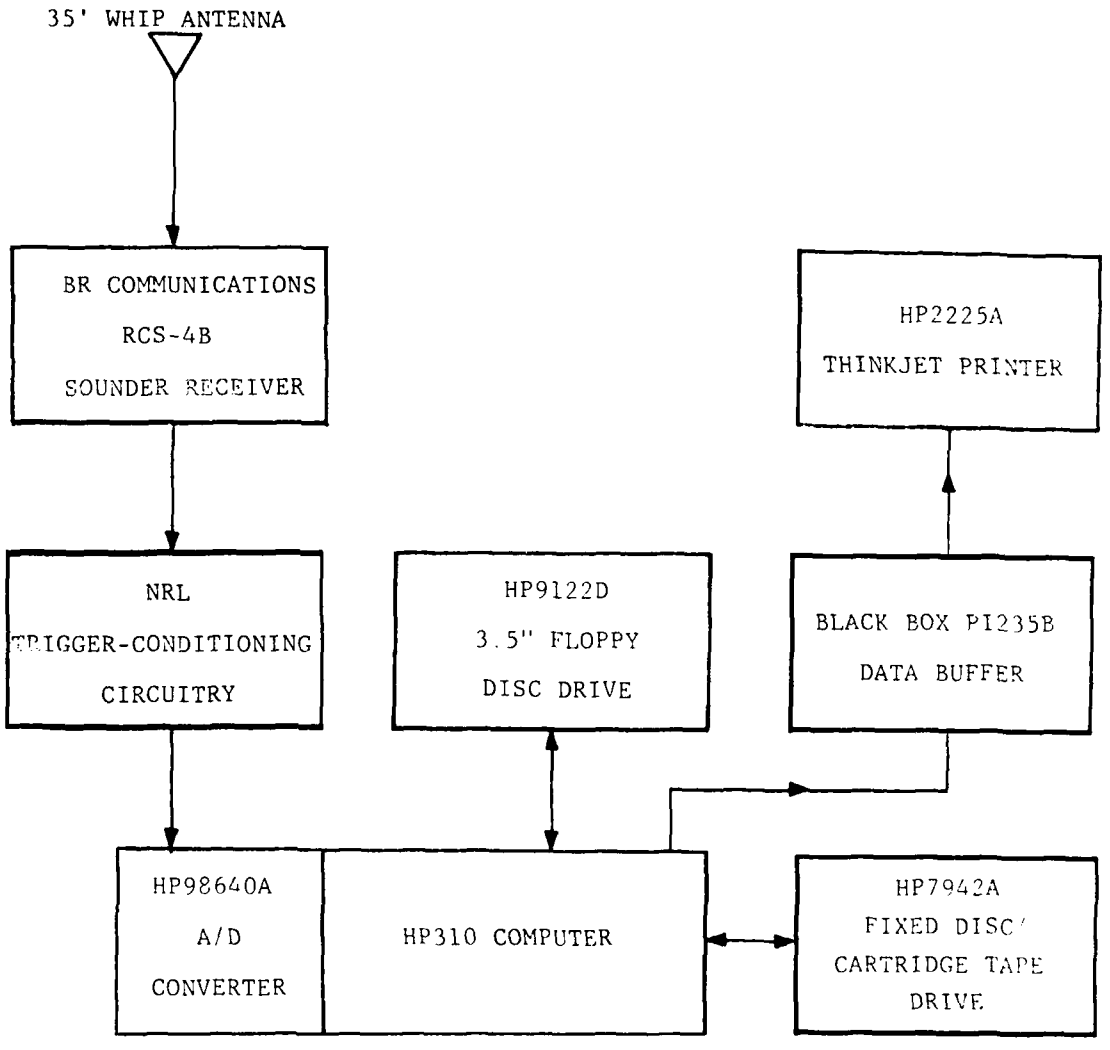

Figure 2. Block diagram of the oblique-incidence-sounder data collection system.

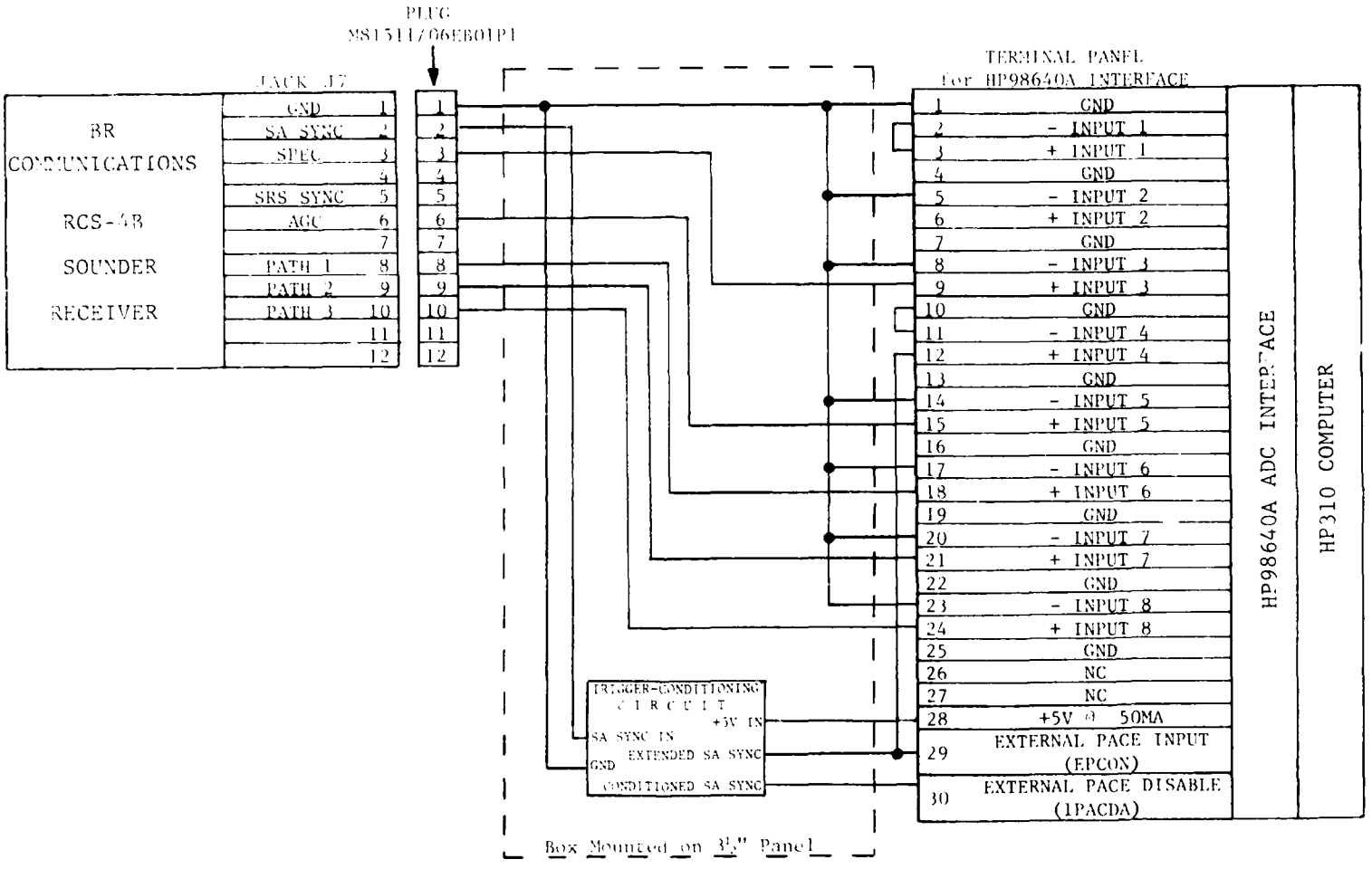

Figure 3. Electrical circuitry connecting the RCS-4B sounder receiver, the trigger-conditioning circuit, and the ADC interface attached to the HP310 computer.

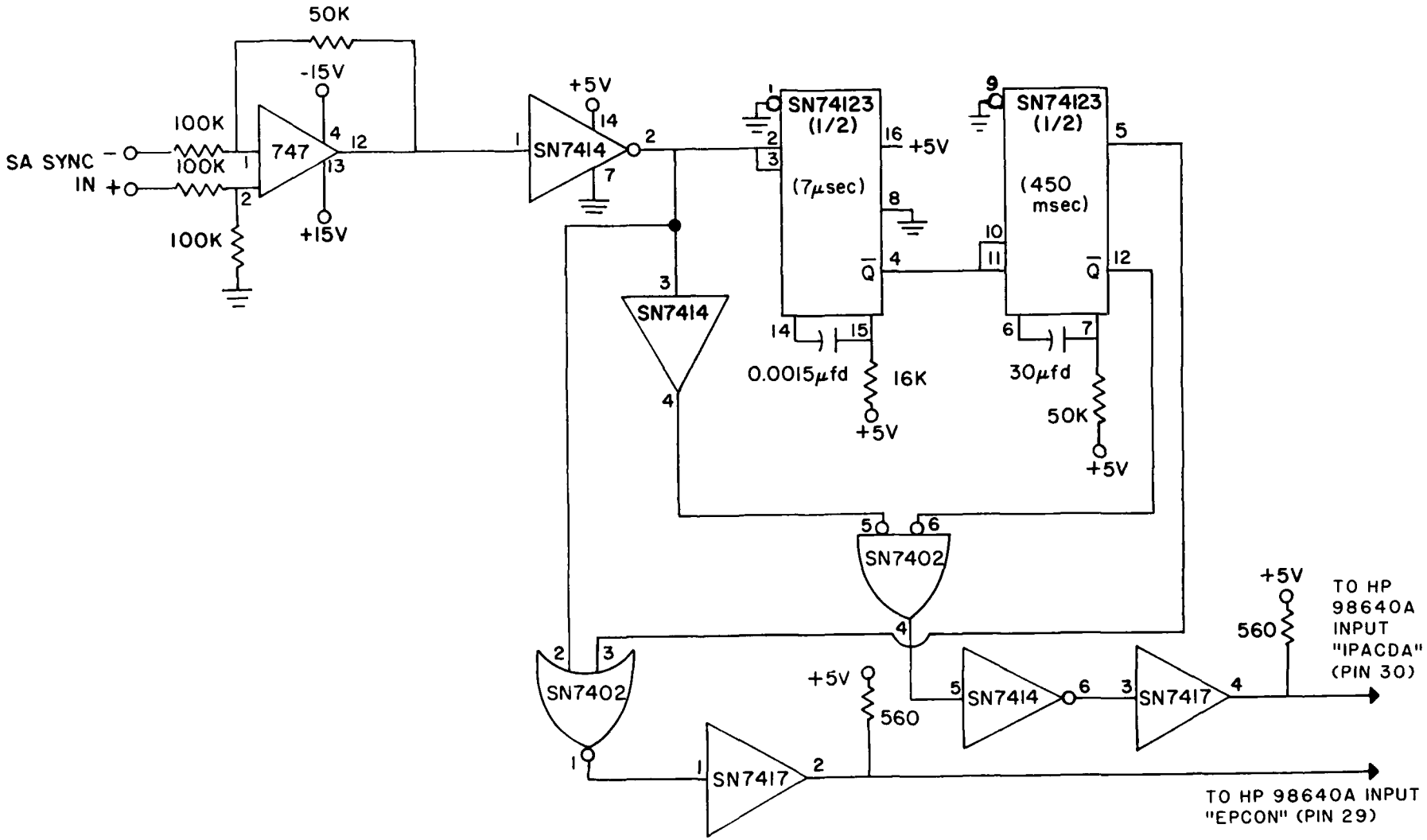

Figure 4. Circuitry used to isolate the sounder receiver's SA Sync pulse, and to generate an additional "EPCON" pulse required by the A/D converter.

APPENDIX. CHIRP4 LISTING

This BASIC program is written for Hewlett-Packard 300-series computers. The fixed-disc is addressed ":7942,1402,0" and the 1/4" magnetic cartridge tape unit designation is "HP7942,1402,1". Lines 1155-1166 represent machine-language subprograms from the HP98645A Measurement Library, which permit BASIC control of the HP98640A A/D converter.

```
1   !  PROGRAM CHIRP4
2   !
3   !  This program for the Hewlett-Packard 310 computer enables data from
4   !  a Barry Research RCS-4B ionospheric sounder receiver to be recorded
5   !  on an HP7942 fixed-disc storage unit, and to be reproduced on an
6   !  HP 2225A Thinkjet printer.
7   !
8   !  Up to 291 ionograms may be stored in the "IONOGRAMS" fixed-disc file.
9   !  In routine operation, the "IONOGRAMS" file is filled, copied onto a 1/4"
10  !  cartridge magnetic tape, and then purged, making it possible to fill
11  !  another "IONOGRAMS" file.  Up to four such files, typically named
12  !  IONOGRAMS1", "IONOGRAMS2", "IONOGRAMS3", and "IONOGRAMS4", can be
13  !  copied onto a single 65-Mbyte tape.
14  !
15  !  The "IONOGRAMS" fixed-disc file contains 41614 records of 400 bytes each.
16  !  Data for individual ionograms are stored in successive blocks fo 143
17  !  records, each of which has the followig format:
18  !
19  !         Rec.   1     Header (400 characters)
20  !         Recs. 2-3    IAGC, 279 integers of AGC dta (in 400-element array)
21  !         Rec.   4     200 integers representing SPEC data for first sweep
22  !         Recs.5-143   139 records of 200 characters each, in which the
23  !                      least significant bytes represent SPEC data for one
24  !                      sweep and the more significant bytes represent SPEC
25  !                      data for the following sweep
26  !
27  !  Record 41614 contains (in I4 format) the number of ionograms recorded
28  !  in the "IONOGRAMS" file.
29  !
30  !  The CSUB routines at the end of this program must be loaded from the
31  !  HP98645A software for the HP98640A ADC interface.  They are required
32  !  only for the RECORD function.
33  !
34  !
35  !  Program written by:
36  !                  Mark Daehler
37  !                  Code 4181
38  !                  Naval Research Laboratory
39  !                  Washington, DC  20375
40  !                  (202)767-2891
41  !
42  !  Latest revision:  5 April 1988
43  !
44      OPTION BASE 1
45      GINIT
46      PRINTER IS 1
47      CONTROL CRT,12;1     ! Key labels off
48      PRINT CHR$(128)      ! Stop blinking and inverse video, if on
49      OUTPUT 1;CHR$(255,3)CHR$(75);      ! Clear screen
50      MASS STORAGE IS ":HP7942,1402"     ! Fixed-disc/cartridge tape combination
51      CONTROL 1,5;1        ! Makes HIL keyboard (300 series kbd) compatible
52                           ! with 98203 keyboard (the kbd on HP9836)
```

```
53      DIM Soundata(5),Sdata(400),Agc(400),Title$[396],Housekeep(7),Spec(200),Tmp
t(279),Path$(0:3)[28],U$[180],O$[10],Text$[80],Tt$[80],Dt$[31],Temp(200)
54      DIM Lat(3),Long(3),Opseg$(3)[20],Newpath$[28],Newopseg$[20],A$[200]
55      INTEGER Ispec(200),Iagc(400),Iout(200),Gridarray(25600),Imonth,Path,Itemp
(200),Tdelay(0:3,2),Tdmin,Tdsec,Jcattest
56      ALLOCATE Qcat$(294)[48]
57      Function$="PROGRAMSTART"
58      Gridready$="NO"
59      Catuptodate$="NO"
60      Journal$="NOJOURNAL"
61      DIM Mon$[36],Mon2$[24]
62      Mon$="JANFEBMARAPRMAYJUNJULAUGSEPOCTNOVDEC"
63      Mon2$="JAFEMRAPMYJNJLAUSEOCNODE"
64      Discrim=.45
65      Halt$=""                                                    ! Reset time if
66      IF TIMEDATE<2.11371724815E+11 THEN GOTO Settime  ! T    ! Jan 96 00:00:00
67 Menu:!
68      Oldfunction$=Function$
69      Function$="MENU"
70      IF Oldfunction$="CHANGEPATHS" THEN GOTO 73
71      OUTPUT KBD:CHR$(255)&CHR$(75);    ! Clear screen
72      IF Oldfunction$="SETTIME" THEN GOSUB Displaytime
73      PRINTER IS 1
74      OFF ERROR
75      CONTROL CRT,12:0    ! Turn on user-key labels
76      ON KEY 0 LABEL "RECORD",1 GOTO Record
77      ON KEY 1 LABEL "DISPLAY",1 GOTO 330
78      ON KEY 2 LABEL "LIST    GRAMS",1 GOSUB 517
79      ON KEY 3 LABEL " PURGE " GOTO Purge
80      ON KEY 4 GOSUB Do_nothing
81      ON KEY 5 GOSUB Do_nothing
82      ON KEY 6 LABEL " QUIT" GOTO End
83      ON KEY 7 GOSUB Do_nothing
84      ON KEY 8 LABEL "CHANGE PATHS",1 GOTO Changepaths
85      ON KEY 9 LABEL " SET    TIME",1 GOTO Settime
86      IF Function$<>"SETTIME" THEN GOTO 89
87        PRINT USING 556:DATE$(TIMEDATE),TIME$(TIMEDATE)
88        GOTO Loop
89      IF Oldfunction$="PROGRAMSTART" THEN
90        CONTROL CRT,1:11        ! Set to CRT line 11
91        A$=RPT$(" ",20)
92        PRINT A$;"        NAVAL RESEARCH LABORATORY"
93        PRINT A$;"        WASHINGTON, DC 20375  USA"
94        PRINT
95        PRINT A$;"CHIRPSOUNDER IONOGRAM RECORDING PROGRAM"
96        Function$=""
97       END IF
99      IF Function$="DISPLAY" THEN PRINT RPT$(CHR$(10),3)&RPT$(" ",3);"THE 'IONO
GRAMS' FILE CONTAINS NO IONOGRAMS FROM THE REQUESTED PATHS"
99      CONTROL CRT,12:2      ! Key labels always on
100     Function$="MENU"
101 Loop:       GOTO Loop
```

```
154     CONTROL @Grampath,7:4!614     ! Set EOF pointer to end of file
155     GOSUB Plot_grid
156     Catuptodate$="NO"
157     U$=RPT$(" ",75)
158     OFF KEY
159     ON KEY 0 GOTO Do_nothing
160     ON KEY 1 GOTO Do_nothing
161     ON KEY 2 GOTO Do_nothing
162     ON KEY 3 GOTO Do_nothing
163     ON KEY 4 GOTO Do_nothing
164     ON KEY 5 GOTO Do_nothing
165     ON KEY 6 LABEL " QUIT",1 GOTO 65
166     ON KEY 7 GOTO Do_nothing
167     ON KEY 8 GOTO Do_nothing
168     ON KEY 9 GOTO Do_nothing
169     CONTROL CRT,12:2     ! Key labels on
170     PRINT RPT$(CHR$(10),15)     !  CHR$(10)=line feed
171     PRINT USING """IONOGRAM""",4D":Gramnum
172     PRINT
173     PRINTER IS 1:EOL CHR$(13)  ! CR only (no linefeed) after PRINT statement
174     PRINT "SWEEP"
175     IMAGE 5 K,4D
176 Start_search:   Time1=TIMEDATE     ! Wait for beginning of ionogram
177     Sequential_scan("SPECTRUM",2,2,.000301,Spec(*),200)
178     Sequential_scan("SOUNDER",1,7,.00002,Houskeep(*),1)
179     Time2=TIMEDATE  ! TIME2 is start time for this ionogram
180     IF (Time2-Time1)<1,10 THEN GOTO First_scan
181     WAIT .10
182     GOTO Start_search
183 First_scan:   Path=-(SGN(Houskeep(5)-2.5)-1)/2-(SGN(Houskeep(6)-2.5)-1)-3*(S
GN(Houskeep(7)-2.5)-1)/2
184     K=1
185     Age(K)=Houskeep(4)
186 Plot_data:   FOR J=1 TO 200    ! Plot data for first sweep
187       Spec(J)=MAX(0,Spec(J))
188       IF Spec(J)<Discrim THEN 191
189       PLOT K,J
190       PENUP
191     NEXT J
192     IF Path<0 OR Path>3 THEN Path=0
193     U$=Path$(Path+1,2)&RPT$(" ",29)     ! U$=Name of ionogram
194     U$=U$[1,28]
195     Tim$=TIME$(Time2)
196     D1=VAL(Tim$[4,5])
197     IF FRACT(D1/5.0)=0 THEN GOTO 200
198     D1=D1+1
199     GOTO 197
200     D1$="00"&VAL$(D1)
201     D1$=D1$[LEN(D1$)-1,LEN(D1$)]
202     Dat$=DATE$(Time2)
203     Imonth=POS("JanFebMarAprMayJunJulAugSepOctNovDec",Dat$[4,6])/3+1/3
204     D$=Dat$[1,2]&Mon$[2*Imonth-1,2*Imonth]&Dat$[10,11]&Tim$[1,2]&D1$
205     IF D$[1,1]=" " THEN D$="0"&D$[2,10]
```

```
206     MAT Ispec= (51.2)*Spec          ! 51.2=256/5.0
207     OUTPUT @Gramoath;4+143*(Gramnum-1):Ispec(*)
208     PRINT USING 228;K
209     RPLOT 1,220+10*Agc(1)
210     PENUP
211     FOR K1=1 TO 139
212     MAT Ispec= (-32768)
213     K=2*K1
214 Even_scan:Sequential_scan("SPECTRUM",2,2,.00030),Spec(*),200
215     Sequential_scan("SOUNDER",1,7,.00002,Housekeep(*),1)
216     Agc(K)=Housekeep(4)
217     FOR J=1 TO 200    ! PLOT DATA FOR THIS SWEEP
218        Spec(J)=MAX(0,Spec(J))
219        IF Spec(J)>Discrim THEN 222
220        RPLOT K,J
221        PENUP
222      NEXT J
223     MAT Itemp= (51.2)*Spec   ! Round spectrum values to integers
224     MAT Temp= Itemp          ! Convert to real
225     MAT Temp= (256.0)*Temp
226     MAT Ispec= Ispec+Temp
227     PRINT USING 228;K
228     IMAGE "SWEEP ",3D
229     RPLOT K,220+10*Agc(K)
230     PENUP
231     IF K1=1 THEN
232        CSIZE 4,.5
233        MOVE 366,375
234        LABEL D$
235        MOVE Xzero,Yzero
236      END IF
237     IF K1=2 THEN
238        MOVE 76,360
239        CSIZE 4,.406
240        LABEL USING "3D.2D";Discrim
241        MOVE Xzero,Yzero
242      END IF
243     IF K1=3 THEN
244        MOVE 76,345
245        LABEL USING "3D.2";Path
246        MOVE Xzero,Yzero
247      END IF
248     IF K1=4 THEN
249        MOVE 76,330
250        CSIZE 4,.406
251        LABEL USING "4A";Path$[1,4]
252        MOVE Xzero,Yzero
253      END IF
254     IF K1=5 THEN
255        MOVE 76,350
256        CSIZE 4,.406
257        LABEL USING "14X,4A";Path$[5,8]
```

```
258         MOVE Xzero,Yzero
259       END IF
260 Odd_scan:          K=K+1
261     Sequential_scan("SPECTRUM",2,2,.000301,Spec(*),200)
262     Sequential_scan("SOUNDER",1,7,.00002,Housekeep(*),1)
263     Agc(K)=Housekeep(4)
264     FOR J=1 TO 200    ! PLOT DATA FOR THIS SWEEP
265        Spec(J)=MAX(0,Spec(J))
266        IF Spec(J)>Discrim THEN 269
267        RPLOT K,J
268        PENUP
269        NEXT J
270        MAT Temp= (51.2)*Spec
271        MAT Ispec= Ispec+Temp
272        PRINT USING 228:K
273        RPLOT K,220+10*Agc(K)
274        PENUP
275        OUTPUT @Grampath;Ispec(*)
276       NEXT K1
277     PRINTER IS 1
278     MAT Iagc= (51.2)*Agc
279     Delay$="0"&VAL$(Tdelay(Path,2))
280     Delay$=Delay$[LEN(Delay$)-1,LEN(Delay$)]&"S"
281     D$="0"&VAL$(Tdelay(Path,2))
282     Delay$=D$[LEN(D$)-1,LEN(D$)]&"M"&Delay$     ! PATH DELAY (XXMYYS): 5 CHRS
283     Title$=D$&"  "&U$[1,28]&"  PATH "&VAL$(Path)&"  "&Delay$&"  "&Dat$&"  "&T
im$
284     Title$=Title$&RPT$(" ",396-LEN(Title$))    ! Title$ IS 396 CHARACTERS LONG
285     OUTPUT @Grampath,1+143.0*(Gramnum-1) USING "396A":Title$
286     OUTPUT @Grampath;Iagc(*)
287     Gramnum=Gramnum+1
288     Jcat=Jcat+1
289     Qcat$(Jcat)=D$
290     OUTPUT @Grampath,4*514 USING "4D":Jcat
291     PRINT "ALL DONE   "
292     MOVE Xzero,Yzero+220
293     FOR I=1 TO 279
294     IF Agc(I)>0 THEN 296
295     RPLOT I,0
296     RPLOT I,10*Agc(I)
297     PENUP
298     NEXT I
299     MOVE 75,360
300     CSIZE 4,.406
301     LABEL USING 302:U$,Dat$,Tim$
302     IMAGE 28A,10X,9A,2X,8A,"Z"
303     IF Journal$="NOJOURNAL" THEN GOTO 308
304     PRINTER IS 701
305     PRINT USING 306:U$,Path,Dat$,Tim$,D$
306     IMAGE 28A," PATH=",D.2D,3X,"11A,1X,9A," Z",3X,10A
307     PRINTER IS 1
308     OUTPUT KBD;CHR$(255)&CHR$(25);          ! Clear ALPHA screen
309     GOTO 155
```

```
310 !
311 ! ************* OUTPUT IONOGRAM TO HP2225A THINKJET PRINTER *************
312 !
313 Hard_copy:  Function$="HARDCOPY"
314    PRINTER IS 1
315    PRINT TABXY(1,1);          ! Move cursor to upper left-hand corner of CRT
316    PRINT RPT$(CHR$(10),15)    ! 15 line-feeds
317    PRINT "            "       ! Remove "IONOGRAM" from CRT
318    PRINT "            "       ! Remove "XXX OF XXX" from CRT
319    PRINT "             "      ! Remove "SWEEP XXX" from CRT
320    PRINTER IS 701
321    GRAPHICS ON
322!   CLEAR 7  ! This command required when using HP2571G printers
323    INTEGER S2(25600)
324    STATUS CRT,12;Zzz
325    CONTROL CRT,12;1
326    GSTORE S2(*)
327    DUMP GRAPHICS
328    RETURN
329 !
330 ! *************** DISPLAY IONOGRAMS FROM DISC ***********************
331 !
332    PRINTER IS 1
333    OFF TIME
334    OUTPUT KBD;CHR$(255)&CHR$(75);     ! Clear screen
335    GRAPHICS OFF
336    Function$="DISPLAY"
337    IF Catuptodate$="NO" THEN
338       CONTROL CRT,1;11      ! Set CRT cursor to line 11
339       PRINT RPT$(" ",19);"READING LIST OF IONOGRAMS ON HARD DISC"
340       GOSUB List_grams
341       CONTROL CRT,1;11
342       PRINT RPT$(" ",80)
343       CONTROL CRT,1;1
344      END IF
345    OFF KEY
346    ON KEY 0 GOSUB Do_nothing
347    ON KEY 1 GOSUB Do_nothing
348    ON KEY 2 LABEL " LIST   GRAMS",1 GOTO Remindoperator
349    ON KEY 3 GOSUB Do_nothing
350    ON KEY 4 GOSUB Do_nothing
351    ON KEY 5 GOSUB Do_nothing
352    ON KEY 6 LABEL "  QUIT",1 GOTO 74
353    ON KEY 7 GOSUB Do_nothing
354    ON KEY 8 GOSUB Do_nothing
355    ON KEY 9 GOSUB Do_nothing
356    CONTROL CRT,12;2      ! Key labels on
357    Quant=0      ! Quant= number of ionograms to be plotted
358    STATUS CRT,1;R    ! R = Current CRT line position
359    PRINT " ENTER names of ionograms to be plotted as in following examples:"
360    PRINT
```

```
361     PRINT "         SINGLE IONOGRAM:                    2AP860005"
362     PRINT "         MULTIPLE IONOGRAMS:              2JU860015-3JU861025"
363     PRINT "         ALL, OR ALL OF ONE PATH:                ALL"
364     PRINT
365     CONTROL CRT,12:2          ! Key labels on
366     PRINT " CHOICE:    ";
367     Q1$=""
368     K=0
369     GOSUB Askfora
370     Q1$=TRIM$(UPC$(A$[1,31]))
371     IF Q1$="" THEN GOTO 365
372     IF Q1$="ALL" THEN
373        Qfirst$=Qcat$(1)[1,10]
374        Qlast$=Qcat$(Jcat)[1,10]
375        GOTO 381
376       END IF
377     Ipos=POS(Q1$,"-")
378     IF Ipos=0 THEN
379        Qfirst$=TRIM$(Q1$)
380        Qlast$=TRIM$(Q1$)
381        Quant=1      ! Quant= number of ionograms to be plotted
382        GOTO 387
383       END IF
384     IF Ipos<9 THEN GOTO 365
385     Qfirst$=Q1$[1,Ipos-1]
386     Qlast$=Q1$[Ipos+1,LEN(Q1$)]
387     IF LEN(Qfirst$)>10 THEN Qfirst$=Qfirst$[1,10]
388     IF LEN(Qlast$)>10 THEN Qlast$=Qlast$[1,10]
389     IF LEN(Qfirst$)=9 THEN Qfirst$="0"&Qfirst$
390     IF LEN(Qlast$)=9 THEN Qlast$="0"&Qlast$
391     IF Catuotodate$="NO" THEN GOSUB List_grams
392     FOR K1=1 TO Jcat
393        Kfirst=K1
394        IF Qfirst$=Qcat$(K1)[1,10] THEN GOTO Next_ones
395       NEXT K1
396     PRINT USING 397:Qfirst$
397     IMAGE " THERE IS NO IONOGRAM  ",K," .  ENTER REQUEST AGAIN."
398     GOTO 365
399 Next_ones:   FOR K2=1 TO Jcat
400        Klast=K2
401        IF Qlast$=Qcat$(K2)[1,10] THEN GOTO Choose_path
402       NEXT K2
403     PRINT USING 404:Qlast$
404     IMAGE "THERE IS NO IONOGRAM  ",K," .  ENTER REQUEST AGAIN."
405     GOTO 357
406 Choose_path:  Stepsize=SGN(Klast-Kfirst)
407     IF Stepsize=0 THEN Stepsize=1
408     IF Quant=1 THEN GOTO 410
409     PRINT PRT$;CHR$(10);3;    ! 3 line feeds
410     PRINT
```

```
411     PRINT "TO DISPLAY IONOGRAMS FROM JUST 1 OR TWO PATHS RETURN PATH NUMBERS.
"
412     PRINT "FOR EXAMPLE, FOR JUST PATH 1 RETURN     1"
413     PRINT "              FOR PATHS 2 AND 3 RETURN   23"
414     PRINT "FOR ALL PATHS, PUSH RETURN"
415     PRINT
416     PRINT "CHOICE: ";
417     GOSUB Askfora
418     IF A$="" THEN GOTO 428
419     Plot1=0
420     Plot2=0
421     Plot3=0
422     FOR K=1 TO LEN(A$)
423        IF A$[K,K]="1" THEN Plot1=1
424        IF A$[K,K]="2" THEN Plot2=2
425        IF A$[K,K]="3" THEN Plot3=3
426      NEXT K
427     IF Plot1+Plot2+Plot3<>0 THEN GOTO 431
428     Plot1=1
429     Plot2=2
430     Plot3=3
431     FOR Pathee=1 TO 3      ! Plot all of path 1, then path 2, then path 3
432        IF Pathee=1 AND Plot1<>1 THEN GOTO Next_pathee
433        IF Pathee=2 AND Plot2<>2 THEN GOTO Next_pathee
434        IF Pathee=3 AND Plot3<>3 THEN GOTO Next_pathee
435        Quant=0
436        FOR Kk2=Kfirst TO Klast STEP Stepsize
437           IF Qcat$(Kk2)[48,48]=VAL$(Pathee) THEN Quant=Quant+1
438         NEXT Kk2
439        IF Quant<>0 THEN GOTO Goahead
440        GOTO Next_pathee
441 Remindoperator:    GOSUB 617      ! Fetch list of ionograms
442                    GOTO 356       ! Go back & ask for grams to be displayed
443 Goahead:  Newpage$="YES"  ! 2 ionograms per page
444        ON KEY 2 GOTO Do_nothing
445        Nowk=0
446        FOR Kk2=Kfirst TO Klast STEP Stepsize
447           Q1$=Qcat$(Kk2)[1,10]
448           IF Qcat$(Kk2)[48,48]<>VAL$(Pathee) THEN GOTO 461
449           Nowk=Nowk+1
450           GOSUB Displaygram                ! This is the routine in which a
451           PRINTER IS 701                   ! series of ionograms is plotted.
452           IF Newpage$="YES" THEN
453              PRINT CHR$(12)                ! CHR$(12)=page eject
454              PRINT CHR$(10);CHR$(13)       ! CHR$(10)=wide line feed
455              Newpage$="NO"                 ! CHR$(13)=narrow line feed
456            ELSE
457              PRINT CHR$(10)                ! line feed
458              Newpage$="YES"
459            END IF
460           GOSUB Hard_copy
```

```
461          NEXT Kk2
462 Next_pathee:       NEXT Pathee
463     PRINTER IS 1
464     CONTROL CRT,12:2    ! KEY LABELS ON
465     GOTO 55
466 Disola,gram:   ! IF LEN(Q1$)<10 THEN Q1$=Q1$&"0"
467     OUTPUT KBD:CHR$(255)&CHR$(75);       ! Clear screen
468     GOSUB Plot_grid
469     MOVE 366,375
470     CSIZE 4,.5
471     IF LEN(Q1$)=10 AND Q1$[10,10]<>" " THEN GOTO 474
472     LABEL " "&Q1$
473     GOTO 475
474     LABEL Q1$
475     PRINTER IS 1
476     PRINT RPT$(CHR$(10),15)       ! CHR$(10)=Line feed
477     IF Qlast$="" THEN GOTO 481
478     PRINT "  IONOGRAM"
479     PRINT USING 480:Nowk,Quant
480     IMAGE 3D," OF ",3D
481     PRINTER IS 1;EOL CHR$(13)     ! End of line sequence is CR only (no LF)
482     PRINT USING 515
483     ENTER @Gramoath,1+143*(Kk2-1) USING "396A";Title$
484     Q$=Title$[1,10]
485     U$=Title$[13,40]
486     Path=VAL(Title$[48,48])
487     Delay$=Title$[51,56]
488     Dat$=Title$[59,69]
489     Tim$=Title$[72,79]
490     ENTER @Gramoath;Iago(*)
491     MOVE 75,360
492     CSIZE 4,.406
493     LABEL USING 494:U$,Discrim,Dat$[1,2]&Dat$[4,5]&Dat$[8,11],Tim$
494     IMAGE 28A," D=",,2D,3X,3A,2X,3A,"Z"
495     LABEL USING 496:Path
496     IMAGE "3X,D
497     MAT Agc= Iago/(51.2)
498     MOVE Zero,Zero+220    ! Get in position to plot AGC signal
499     FOR J=1 TO 279
500       IF Agc(J)<0 THEN GOTO 502
501       RPLOT J,0
502       RPLOT J,10*Agc(J)
503       PENUP
504     NEXT J
505     MOVE Zero,Zero
506 First_sweep:   ENTER @Gramoath,4+143*(Kk2-1);Ispec(*)
507     K=1
508     MAT Spec= (5.0/256.0)*Ispec
509     FOR J=1 TO 200
510       IF Spec(J)<Discrim THEN 513
```

```
511         RPLOT K,J
512         PENUP
513       NEXT J
514     PRINT USING 515:K
515     IMAGE "  SWEEP ",3D
516     FOR K1=1 TO 139
517         ENTER @Grampath:Ispec(*)
518 Even_sweep:  K=2*K1
519         MAT Spec= Ispec
520         MAT Spec= Spec+(32768)
521         MAT Spec= Spec/(256)
522         FOR J=1 TO 200
523           Spec(J)=INT(Spec(J))
524           Spec(J)=Spec(J)/51.2
525           IF Spec(J)<Discrim THEN 528
526           RPLOT 2*K1,J
527           PENUP
528         NEXT J
529         PRINT USING 515:K
530 Odd_sweep: K=2*K1+1
531         MAT Spec= Ispec
532         MAT Spec= Spec+(32768)
533         FOR J=1 TO 200
534           Spec(J)=Spec(J) MODULO 256
535           Spec(J)=Spec(J)/51.2
536           IF Spec(J)>Discrim THEN GOTO 539
537           RPLOT 2*K1+1,J
538           PENUP
539         NEXT J
540         PRINT USING 515:K
541       NEXT K1
542     PRINTER IS 1
543     RETURN
544   !
545   ! ***************************** SET TIME *********************************
546   !
547 Settime:  Oldfunction$=Function$
548     Function$="SETTIME"
549     OUTPUT KBD:CHR$(255)&CHR$(75);     ! CLEAR SCREEN
550     ON KEY 0 GOSUB Do_nothing
551     ON KEY 1 GOSUB Do_nothing
552     ON KEY 2 GOSUB Do_nothing
553     ON KEY 3 GOSUB Do_nothing
554     ON KEY 5 LABEL " QUIT" GOTO 510
555     ON KEY 8 GOSUB Do_nothing
556     ON KEY 9 GOSUB Do_nothing
557     GOSUB Displaytime
558     PRINT
559     PRINT "Date or time stated above may be retained by entering RETURN."
560     PRINT
```

```
561     PRINT "ENTER UNIVERSAL DATE   (DD MMM YYYY) ";
562     OFF ERROR
563     STATUS CRT,1:Nowline
564     STATUS CRT,0:Nowcol
565     GOSUB Askfora
566     Oldyrsecs=DATE(DATE$(TIMEDATE))    ! Old date in seconds
567     IF A$="" THEN
568        CONTROL CRT,1:Nowline
569        CONTROL CRT,0:Nowcol
570        PRINT DATE$(TIMEDATE)
571        Newyrsecs=0
572        GOTO 582
573      END IF
574     CONTROL CRT,1:Nowline
575     CONTROL CRT,0:1
576     ON ERROR GOTO 560
577     Newyrsecs=DATE(A$)
578     IF Newyrsecs<2.08662912E+11 THEN GOTO 560
579     IF Newyrsecs>2.14322522224E+11 THEN GOTO 560
580     OFF ERROR
581     Date$=A$
582     Nowline=Nowline+1
583     CONTROL CRT,1:Nowline+1
584     CONTROL CRT,0:1
585     PRINT "ENTER ZULU TIME (HH MM SS) ";
586     OFF ERROR
587     STATUS CRT,1:Nowline
588     STATUS CRT,0:Nowcol
589     GOSUB Askfora
590     Oldtimesecs=TIME(TIME$(TIMEDATE))    ! =time when lbd RETURN was pushed
591     IF A$="" THEN
592        IF Newyrsecs=0 THEN GOTO 510
593        Newtimedate=TIMEDATE-Oldyrsecs+Newyrsecs
594        SET TIMEDATE Newtimedate
595        GOTO 510
596      END IF
597     Nowline=Nowline+1
598     CONTROL CRT,1:Nowline
599     CONTROL CRT,0:1
600     ON ERROR GOTO 585
601     Newtimesecs=TIME(A$[1,2]&":"&A$[4,5]&":"&A$[7,8])
602     IF Newtimesecs<0 THEN GOTO 585
603     IF Newtimesecs>86399.999 THEN GOTO 585
604     OFF ERROR
605     IF Newyrsecs=0 THEN
606        SET TIMEDATE Oldyrsecs+Newtimesecs
607        GOTO 510
608      END IF
609     SET TIMEDATE Newyrsecs+Newtimesecs
610     OUTPUT KBD:CHR$(255)&CHR$(75);          ! Clear screen
```

```
611     OFF ERROR
612     IF Oldfunction$="RECORD" THEN GOTO Record
613     GOTO Menu
614   !
615   !************** PRODUCE CATALOG OF HARD-DISC IONOGRAMS ********************
616   !
617     Oldfunction$=Function$
618     Function$="LISDISCGRAMS"
619 List_grams:   GRAPHICS OFF
620     Ac$=""
621     IF Catuptodate$="YES" THEN GOTO 645
622     ASSIGN @Grampath TO *
623     ON ERROR GOTO File_error        ! IF NO "IONOGRAMS" FILE, CREATE ONE
624     ASSIGN @Grampath TO "IONOGRAMS"
625     OFF ERROR
626     CONTROL @Grampath,7:41614     ! MOVES EOF MARKER TO END OF FILE
627     ENTER @Grampath,41614 USING "4D":Jcattest
628     IF Jcattest=0 THEN
629        Jcat=0
630        IF Function$="RECORD" THEN GOTO 633
631        IF Function$="DISPLAY" THEN GOTO 633
632        PRINT "THERE ARE NO IONOGRAMS RECORDED ON THE HARD DISC"
633        Catuptodate$="YES"
634        RETURN
635       END IF
636     IF Jcat=Jcattest THEN GOTO 643
637     Jcat=Jcattest
638     FOR K=1 TO Jcat
639        ON ERROR GOTO 643
640        ENTER @Grampath,1+143*(K-1) USING "336A":Title$
641        Qcat$(K)=Title$[1,48]
642       NEXT K
643      OFF ERROR
644     Catuptodate$="YES"
645     IF Function$="RECORD" THEN RETURN
646     IF Function$="DISPLAY" THEN RETURN
647     PRINTER IS 1
648     OUTPUT KBD;CHR$(255)&CHR$(75);    ! Clear screen
649 Display_list: PRINT USING 650:Jcat
650     IMAGE 3X,"THE DISC CONTAINS THE FOLLOWING",4D," IONOGRAMS:"
651     FOR Ky=1 TO Jcat/6+1
652        PRINT USING 653:Qcat$(6*Ky-5),Qcat$(6*Ky-4),Qcat$(6*Ky-3),Qcat$(6*Ky-2
),Qcat$(6*Ky-1),Qcat$(6*Ky)
653        IMAGE 6(10A,2X)
654       NEXT Ky
655     PRINT USING "K,#":"HARD COPY (Y,N) ?
656     A$=""
657     GOSUB Askfora
658     IF UPC$(A$[1,1])="Y" THEN
659        STATUS CRT,1;Aaa
660        CONTROL CRT,1;Aaa-1
```

```
661         PRINT "
662         RETURN
663       END IF
664     PRINTER IS 701
665     PRINT USING 666:DATE$(TIMEDATE),TIME$(TIMEDATE)
666     IMAGE 8X,11A,2X,8A , "Z"
667     PRINT USING 650:Jcat
668     FOR Ky=1 TO Jcat/6+1
669       PRINT USING 670:Qcat$(6*Ky-5),Qcat$(6*Ky-4),Qcat$(6*Ky-3),Qcat$(6*Ky-2
),Qcat$(6*Ky-1),Qcat$(6*Ky)
670       IMAGE 8X,6(10A,2X)
671     NEXT Ky
672     Ac$=""
673     PRINTER IS 1
674     RETURN
675 File_error:   OFF ERROR
676     ASSIGN @Gramoath TO *
677     ON ERROR GOTO 679
678     PURGE "IONOGRAMS"
679     ON ERROR GOTO 681
680     CREATE BDAT "IONOGRAMS",41614,400
681     OFF ERROR
682     ASSIGN @Gramoath TO "IONOGRAMS"
683     CONTROL @Gramoath,7:41614
684     Jcat=0
685     OUTPUT @Gramoath,41614 USING "4D":Jcat
686     GOTO 624
687 Return: RETURN   ! Return from request for list of fixed-disc ionograms
688   !
689   !************** PURGE IONOGRAMS FROM "IONOGRAMS" FILE ********************
690   !
691 Purge: !
692   OFF KEY
693   CONTROL CRT,12:1     ! KEY LABELS OFF
694   GRAPHICS OFF
695   OUTPUT KBD:CHR$(255)&CHR$(75);     ! CLEAR SCREEN
696       PRINT                          ! REQUEST PERMISSION TO PURGE IONOGRAMS
697       A$=""
698       PRINT USING "38A,#":"PURGE ALL IONOGRAMS FROM DISC ? (Y,N)"
699       INPUT A$
700       PRINT USING "2X,30A":UPC$(A$[1,1])
701       IF UPC$(A$)<>"Y" THEN GOTO 723
702       Tex$=CHR$(131)&"PURGE ALL IONOGRAMS FROM DISC ? (Y,N)"&CHR$(128)
703       ! CHR$(131) AND CHR$(128) TURN INVERSE AND BLINKING ON AND OFF,RESP.
704       PRINTER IS 1
705       PRINT USING "39A,#":Tex$
706       A$=""
707       INPUT A$
708       PRINT USING "3X,30A":A$[1,1]
709       IF UPC$(A$)<>"Y" THEN GOTO 723
710
```

```
711   ON ERROR GOTO Bad_or_no_file          ! IF NO "IONOGRAMS" FILE, SET Jcat=
1
712   ASSIGN @Gram_path TO *
713   ASSIGN @Gram_path TO "IONOGRAMS"
714   ENTER @Gram_path,41614 USING "4D":Jcat
715   OFF ERROR
716   Jcat=0
717   OUTPUT @Gram_path,41614 USING "4D":Jcat
718   Catuptodate$="NO"
719   OUTPUT KBD:CHR$(255)&CHR$(75);    ! CLEAR SCREEN
720   PRINT "ALL IONOGRAMS HAVE BEEN PURGED FROM ""IONOGRAMS"" FILE."
721   MAT Qcat$= ("")
722   GOTO 74
723   OUTPUT KBD:CHR$(255)&CHR$(75);     ! CLEAR SCREEN
724   GOTO 74
725   !
726 Bad_or_no_file:   PRINT "PROBLEM WITH ""IONOGRAMS"" FILE"
727       ON ERROR GOTO 728
728       PURGE "IONOGRAMS"
729       CREATE BDAT "IONOGRAMS:HP7942,1402,0",41614,400
730       ASSIGN @Gram_path TO "IONOGRAMS"
731       OUTPUT @Gram_path,41614 USING "4D":0     ! SETT JCAT=0
732       OFF ERROR
733       RETURN
734   !
735 Plot_grid: ! *************** PLOT GRID ********************************
736   !
737   ! If the ionogram grid pattern is stored in array GRIDARRAY(12480),GLOAD
738   ! it into the crt display.  If it isn't there, get it from the hard disc.
739   ! If it isn't on the disc, generate it.
740   !
741   OUTPUT KBD:CHR$(255)&CHR$(75);    ! CLEAR SCREEN
742   GINIT
743   GCLEAR
744   GRAPHICS ON
745   SHOW 1,512,1,390
746   Xzero=150
747   Yzero=70
748   IF Gridready$="YES" THEN GOTO 867
749   ASSIGN @Gridpath TO *
750   ON ERROR GOTO 755
751   ASSIGN @Gridpath TO "GRAMGRID:HP7942,1402"
752   ENTER @Gridpath;Gridarray(*)
753   OFF ERROR
754   GOTO 867
755   OFF ERROR
756   PLOT Xzero,Yzero
757   IPLOT 0,-9
758   IPLOT 0,9
759   FOR K=1 TO 14
760   IPLOT 10,0
```

```
761  IPLOT 0,-5
762  IPLOT 0,5
763  IPLOT 10,0
764  IPLOT 0,-9
765  IPLOT 0,9
766  NEXT K
767  IPLOT 10,0
768  IPLOT -10,0
769  FOR K=1 TO 5
770  IPLOT 0,20
771  IPLOT 6,0
772  IPLOT -6,0
773  IPLOT 0,20
774  IPLOT 10,0
775  IPLOT -10,0
776  NEXT K
777  IPLOT 0,11
778  IPLOT 0,-10
779  FOR K=1 TO 14
780  IPLOT -10,0
781  IPLOT 0,5
782  IPLOT 0,-5
783  IPLOT -10,0
784  IPLOT 0,9
785  IPLOT 0,-9
786  NEXT K
787  IPLOT 0,-1
788  IPLOT -10,0
789  IPLOT 10,0
790  FOR K=1 TO 5
791  IPLOT 0,-20
792  IPLOT -6,0
793  IPLOT 6,0
794  IPLOT 0,-20
795  IPLOT -10,0
796  IPLOT 10,0
797  NEXT K
798  PENUP
799  PLOT Xzero,Yzero
800  PEN 1
801  CSIZE 4.0,.6
802  FOR K=1 TO 15
803  MOVE Xzero+(K-1)*20-3.5,Yzero-25
804  IF K < 5 THEN GOTO 811
805  MOVE Xzero+(K-1)*20-7.5,Yzero-25
806  A$=VAL$(I+K)
807  LABEL A$[1,1]
808  MOVE Xzero+(K-1)*20,Yzero-25
809  LABEL A$[2,2]
810  GOTO 812
```

```
811  LABEL VAL$(2*K)
812  NEXT K
813  MOVE Xzero+60,Yzero-40
814  LABEL "FREQUENCY  (MHz)"
815  MOVE Xzero,Yzero
816  FOR K=0 TO 5
817  MOVE Xzero-13,Yzero-8+40*K
818  LABEL VAL$(K)
819  NEXT K
820  MOVE Xzero-30,Yzero+120
821  LABEL "TIME"
822  MOVE Xzero-30,Yzero+105
823  LABEL "DELAY"
824  MOVE Xzero-30,Yzero+90
825  LABEL "(mSEC)"
826  PENUP
827  MOVE Xzero,Yzero+220
828  RPLOT 280,0,-1
829  RPLOT 280,51
830  RPLOT 0,51
831  MOVE Xzero-30,Yzero+245
832  LABEL "SIG"
833  MOVE Xzero-30,Yzero+232
834  LABEL "(dBm)"
835  MOVE Xzero,Yzero+220
836   IPLOT -6,0
837   IPLOT 6,0
838   FOR K=1 TO 5
839   IPLOT 0,10
840   IPLOT -6,0
841   IPLOT 6,0
842   NEXT K
843   MOVE Xzero-47,Yzero+213
844   LABEL "-120"
845   MOVE Xzero-38,Yzero+261
846   LABEL "-55"
847   MOVE 76,375
848   CSIZE 4.0,.50
849   LABEL "NAVAL RESEARCH LABORATORY IONOGRAM"
850   MOVE 76,360
851   CSIZE 4,.406
852   LABEL USING 853
853   IMAGE 28x,"D="
854   LABEL "SOUNDER PATH"
855   MOVE Xzero,Yzero
856        !       CONTROL CRT,12:1
857   GSTORE Gridarray(*)
858        !       CONTROL CRT,12:0
859   ASSIGN @Gridpath TO *
860   ON ERROR GOTO 863
```

```
861   PURGE "GRAMGRID"
862   OFF ERROR
863   CREATE BDAT "GRAMGRID:HP7942,1402,0",1,51200
864   OFF ERROR
865   ASSIGN @Gridpath TO "GRAMGRID"
866   OUTPUT @Gridpath:Gridarray(*)
867   ASSIGN @Gridpath TO *
868   GLOAD Gridarray(*)
869   ON KEY 2 GOSUB Do_nothing
870   CONTROL CRT,12:2    ! Key labels displayed at all times
871   Gridarray$="YES"
872   MOVE Xzero,Yzero
873   GRAPHICS ON
874   RETURN
875   !
876 Do_nothing:   RETURN  ! REMOVES FUNCTION OF USER-DEFINED KEYS WHILE RUNNING
877   !
878   ! ************** SUBROUTINE FOR CHANGING PATHLABELS ******************
879   !
880 Pathlabels:   ON ERROR GOTO 886
881       ASSIGN @Path TO *
882       ASSIGN @Path TO "PATHDATA"
883       OFF ERROR
884       ENTER @Path:Path$(*),Lat(*),Long(*),Tdelay(*),Qoseg$(*)
885       RETURN
886       CREATE BDAT "PATHDATA",1,5000
887       OFF ERROR
888       Path$(1)="ISABELA (PR) TO NRL"
889       Path$(2)="CORINNE (UT) TO NRL"
890       Path$(3)="DRIVER  (VA) TO NRL"
891       Lat(1)=0
892       Long(1)=0
893       Lat(2)=0
894       Long(2)=0
895       Lat(3)=0
896       Long(3)=0
897       Tdelay(1,1)=1
898       Tdelay(1,2)=40
899       Tdelay(2,1)=0
900       Tdelay(2,2)=0
901       Tdelay(3,1)=1
902       Tdelay(3,2)=50
903       Qoseg$(1)="00  25  40  55"
904       Qoseg$(2)="05  20  35  50"
905       Qoseg$(3)="00  15  30  45"
906       ASSIGN @Path TO "PATHDATA"
907       OUTPUT @Path:Path$(*),Lat(*),Long(*),Tdelay(*),Qoseg$(*)
908       PRINT "PATHDATA FILE STUFED WITH DATA"
909            PRINT "LENGTH OF Qoseg$(1)=";LEN(Qoseg$(1))
910            PRINT "LENGTH OF Qoseg$(2)=";LEN(Qoseg$(2))
```

```
911             PRINT "LENGTH OF Ooseg$(3)=";LEN(Ooseg$(3))
912             PRINT Ooseg$(*)
913         ASSIGN @Path TO *
914         RETURN
915       !
916 Changepaths:!
917         OUTPUT KBD;CHR$(255)&CHR$(75); ! CLEAR SCREEN
918         OFF TIME
919         CONTROL CRT,12;1     ! KEY LABELS OFF
920         IF Path$(1)="" AND Path$(2)="" AND Path$(3)="" THEN GOSUB Pathlabels
921         PRINT "Present path descriptions are:"
922         U$=CHR$(132)      ! UNDERLINE
923         N$=CHR$(128)      ! STOP UNDERLINING
924         PRINT
925         PRINT USING "36X,K";'Time Delay'
926         PRINT USING 927;U$&"Path"&N$,U$&"Name"&N$,U$&"min"&N$,U$&"sec"&N$,U$&"O
perating Segments"&N$
927         IMAGE 1X,K,8X,K,19X,K,4X,K,5X,K
928         PRINT
929         FOR K=1 TO 3
930         PRINT USING 931;K,Path$(K),Tdelay(K,1),Tdelay(K,2),Ooseg$(K)
931         IMAGE 3D,4X,29A,1X,2D,5X,2D,6X,20A
932         NEXT K
933         PRINT
934         PRINT "To change a path description, ENTER 1,2, or 3."
935         PRINT
936         PRINT "PATH TO BE CHANGED:  ";
937         A$=RPT$("(",200)
938         ON KBD GOTO 953
939         OFF KEY
940         ON KEY 0 GOSUB Do_nothing
941         ON KEY 1 GOSUB Do_nothing
942         ON KEY 2 GOSUB Do_nothing
943         ON KEY 3 GOSUB Do_nothing
944         ON KEY 4 GOSUB Do_nothing
945         ON KEY 5 GOSUB Do_nothing
946         ON KEY 6 LABEL " QUIT",1 GOTO 1021
947         ON KEY 7 GOSUB Do_nothing
948         ON KEY 8 GOSUB Do_nothing
949         ON KEY 9 GOSUB Do_nothing
950         CONTROL CRT,12;2          ! KEY LABELS ON
951         GOTO 951
952         !
953         A$=KBD$
954         CONTROL CRT,12;1          ! KEY LABELS OFF
955         OFF KEY
956         IF A$=CHR$(255)&CHR$(53) THEN GOTO 937
957         PRINT A$
958         ON ERROR GOTO 960
959         IF LEN(A$)=1 AND NUM(A$)<48 AND NUM(A$)<52 THEN GOTO 963
960         OFF ERROR
```

```
961       GOTO 74
962       !
963       OFF ERROR
964       Pth=VAL(A$)
965       PRINT
966       PRINT USING "K,D,K,#":"          New name for path ",Pth,": _____"
967       A$=Path$(Pth)
968       INPUT A$
969       A$=A$&RPT$(" ",28)
970       Newpath$=A$[1,28]
971       PRINT USING "K,#":RPT$(CHR$(8),11)    ! CHR$(8) IS A BACKSPACE
972       PRINT USING "K,#":RPT$(" ",10)
973       PRINT USING "K,#":RPT$(CHR$(8),11)    ! CHR$(8) IS A BACKSPACE
974       PRINT USING "28A":Newpath$
975       PRINT
976       PRINT USING "K,D,K,#":"          New time delay for path ",Pth,":
977       PRINT USING "K,#":"     __ min:"
978       A$=RPT$("(",200)
979       INPUT A$
980       IF A$=RPT$("(",200) THEN
981            Newmin=Tdelay(Pth,1)
982            GOTO 989
983         END IF
984       ON ERROR GOTO 979
985       IF VAL(A$)<0 OR VAL(A$)>9 THEN GOTO 979
986       OFF ERROR
987       Newmin=VAL(A$)
988       Tdelay(Pth,1)=VAL(A$)
989       PRINT USING "K,#":RPT$(CHR$(8),7)    ! CHR$(8)= BACKSPACE
990       PRINT USING "K,#":RPT$(" ",6)
991       PRINT USING "K,#":RPT$(CHR$(8),7)
992       PRINT USING "D,#":Tdelay(Pth,1)
993       PRINT USING "K,#":" min      __ sec"
994       A$=RPT$("(",200)
995       INPUT A$
996       IF A$=RPT$("(",200) THEN GOTO 1001
997       ON ERROR GOTO 995
998       IF VAL(A$)<0 OR VAL(A$)>59 THEN GOTO 995
999       OFF ERROR
1000      Tdelay(Pth,2)=VAL(A$)
1001      PRINT USING "K,#":RPT$(CHR$(8),6)
1002      PRINT USING "K,#":Tdelay(Pth,2)," sec "
1003      Newsec=Tdelay(Pth,2)
1004      PRINT
1005      PRINT USING "K,D,K,#":"          New operating segments for path ",Pth,
          ": _____"
1006      A$=Opseg$(Pth)
1007      INPUT A$
1008      Newopseg$=A$[1,20]
1009    ASSIGN @Path TO *
1010    ASSIGN @Path TO "PATHDATA"
```

```
1011     ENTER @Path:Path$(*),Lat(*),Long(*),Tdelay(*),Doseg$(*)
1012      Path$(Pth)=Newpath$
1013      Tdelay(Pth,1)=Newmin
1014      Tdelay(Pth,2)=Newsec
1015      Doseg$(Pth)=Newdoseg$
1016      ASSIGN @Path TO *
1017      ASSIGN @Path TO "PATHDATA"
1018      OUTPUT @Path:Path$(*),Lat(*),Long(*),Tdelay(*),Doseg$(*)
1019      ASSIGN @Path TO *
1020      GOTO Changepaths
1021    IF Function$="RECORD" THEN GOTO Record
1022    GOTO Menu
1023 !
1024 ! ******** CHANGE # OF IONOGRAMS LISTED IN "IONOGRAMS" DIRECTORY ********
1025 !
1026 ASSIGN @Path TO *
1027 ON ERROR GOTO 1029
1028 ASSIGN @Path TO "IONOGRAMS"
1029  OFF ERROR
1030  CONTROL @Path,7;41614  ! MOVES EOF MARKER TO END OF FILE
1031  ENTER @Path,41614 USING "4D";Jdat
1032  PRINT "LISTED NUMBER OF IONOGRAMS ON TAPE IS ";Jdat
1033  PRINT "ENTER NEW NUMBER OF IONOGRAMS:";
1034  INPUT "=",J
1035  PRINT J
1036  OUTPUT @Path,41614 USING "4D";J
1037  PRINT "NUMBER OF IONOGRAMS HAS BEEN CHANGED TO ";J
1038  GOTO End
1039 !
1040 ! **** ROUTINE TO INPUT DATA FROM KEYBOARD WITHOUT CHANGING KEY LABELS ***
1041 !
1042 Asinfora: A$=""
1043   STATUS CRT,1;Aaa    ! Aaa is current crt line
1044   STATUS CRT,0;Col    ! Col is current line position
1045   Precidence=1
1046   IF Function$="LISTIONOGRAMS" THEN Precidence=2
1047   ON KBD,Precidence GOTO Keyboardin
1048   GOTO 1048
1049 Keyboardin:   Kbdin$=KBD$
1050   IF LEN(Kbdin$)=1 THEN GOTO 1052
1051   IF NUM(Kbdin$[2,2])=80 THEN ! Recognize backspace CHR$(255)&CHR$(80)
1052      IF LEN(A$)=0 THEN GOTO 1054
1053      A$=A$[1,LEN(A$)-1]
1054      GOTO 1063
1055     END IF
1056   IF NUM(Kbdin$[2,2])=82 THEN ! Recognize ahead space  CHR$(255)&CHR$(82)
1057      A$=A$&" "
1058      GOTO 1063
1059     END IF
1060   IF Kbdin$=CHR$(255)&CHR$(83) THEN GOTO Input_done ! Recognize RETURN ke
```

```
1061    GOTO 1048
1062    A$=A$&Kbdin$
1063    IF LEN(A$) 79-Col THEN A$=A$(1,79-Col)
1064    CONTROL CRT,1:Aaa
1065    CONTROL CRT,0:Col+1
1066    PRINT USING "K,K,#":A$,RPT$(' ',80-Col-LEN(A$))
1067    GOTO 1048
1068 Input_done:    OFF KBD
1069    IF Function$="SETTIME" THEN GOTO 1072
1070    IF Function$="MENU" THEN GOTO 1072
1071    OFF TIME
1072    PRINT
1073    RETURN
1074 !
1075 ! ********************* DYNAMIC TIME DISPLAY ***************************
1076 !
1077 Display_time:  ! Subroutine to display time each second
1078    IF Function$="SETTIME" THEN
1079       CONTROL CRT,1:1
1080       CONTROL CRT,0:1
1081       PRINT USING 1082:DATE$(TIMEDATE),TIME$(TIMEDATE)
1082       IMAGE "                UNIVERSAL TIME IS",3X,11A,3X,8A," Z"
1083       ON TIME #(INT(TIMEDATE MOD 86400)+1) GOSUB Display_time
1084       RETURN
1085     END IF
1086    IF Function$="MENU" THEN
1087       CONTROL CRT,1:1
1088       CONTROL CRT,0:1
1089       PRINT USING 1090:DATE$(TIMEDATE),TIME$(TIMEDATE)
1090       IMAGE "                UNIVERSAL TIME IS",3X,11A,3X,8A," Z"
1091       ON TIME #(INT(TIMEDATE MOD 86400)+1) GOSUB Display_time
1092       RETURN
1093     END IF
1094    IF Function$="RECORD" THEN
1095       CONTROL CRT,1:2
1096       CONTROL CRT,0:1
1097       PRINT "Computer clock reads:  ";DATE$(TIMEDATE);"  ";TIME$(TIMEDATE
1098       ON TIME #(INT(TIMEDATE MOD 86400)+1) GOSUB Display_time
1099       RETURN
1100     END IF
1101    RETURN
1149 End:    END
1150  SUB Mass_lib_init
1151  SUB System_init
1152  SUB Init(Name$)
1153  SUB Input(Name$,INTEGER Channel,REAL Var,OPTIONAL INTEGER Scan,REAL Pace)
1154  SUB Sequential_scan(Name$,INTEGER Start,Stop,REAL Period,Data_array(*),OP
TIONAL INTEGER Repeat)
1155  SUB Random_scan(Name$,INTEGER Addr_array(*),REAL Data_array(*),OPTIONAL I
NTEGER Repeat,REAL Pace_array(*),INTEGER Scan_array(*))
```

```
1156  CSUB Set_gain(Name$,INTEGER Gain)
1157  CSUB Set_units(Name$,Units$,OPTIONAL Multiplier,Offset)
1158  CSUB Enable_intr(Name$)
1159  CSUB Disable_intr(Name$)
1160  CSUB Calibrate(Name$,INTEGER Chan,REAL Pace,INTEGER Number)
1161  CSUB Config_2(Name$,OPTIONAL Model$,INTEGER Select_code,Gain,REAL Pace,Rep
ort_err$,Units$,Multiplier,Offset)
```

END

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